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VERIFICATION OF TRANSLATION

I, Michael Wallace Richard Turner, Bachelor of Arts, Chartered Patent Attorney, European Patent Attorney, of 1 Horsefair Mews, Romsey, Hampshire SO51 8JG, England, do hereby declare that I am conversant with the English and German languages and that I am a competent translator thereof;

I verify that the attached English translation is a true and correct translation made by me of the attached specification in the German language of International Application PCT/EP03/12174;

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment or both under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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Magnesium material and uses thereof

The invention relates to a magnesium material (hereinafter referred to as Mg material), as set forth in the classifying portion of claim 1, and uses thereof.

In order to make Mg materials with a C long-fiber reinforcement suitable for technical uses, it is necessary for the strength thereof transversely with respect to the fiber direction to be considerably improved. For that purpose, the material must involve improved bonding of the carbon fibers (C fibers) to the matrix. In addition, it is necessary to prevent alloying elements of the matrix forming at the fibers locally relatively coarse chemical reaction products because such reaction products act as crack initiators and reduce the level of mechanical strength.

Therefore the object of the invention is to provide an Mg material of the kind set forth in the opening part of this specification, whose strength transversely with respect to the fiber direction is considerably improved, wherein alloying elements of the matrix which form relatively coarse chemical reaction products at the fibers are avoided.

In accordance with the invention that object is attained by the features of claim 1. Preferred configurations of the Mg material according to the invention are characterised in claims 2 through 8.

Uses according to the invention of the Mg material according to the invention are claimed in claims 9 through 11.

In accordance with the invention the C long fibers are provided with a thin layer which performs the following functions:

at least one element of the layer material forms with the respective C long fiber a thin, sufficiently homogeneous chemical reaction layer;

the thin layer acts as a diffusion barrier in such a way that the local formation of relatively coarse chemical reaction products of alloying elements of the matrix at the C long fibers is prevented; and

at least one element of the material of the thin layer forms an intermetallic or intermediate compound or mixed crystal zone with the matrix.

In the Mg material according to the invention the layer material is desirably formed by carbide-forming agents. This can involve for example Al, Cr, Ti, Ta, Nb, Hf, Zr or alloys for example on an Ni basis, which contain carbide-forming agents.

The thin layer of the C long fibers can be produced by PVD processes (physical vapor deposition) or by CVD processes (chemical vapor deposition). The PVD process preferably involves sputtering. The CVD process can involve a galvanic, wet-chemical or currentlessly electrochemical process.

The thin layer of the C long fibers can be of a thickness in the region of between some nm and some μm.

The Mg material according to the invention has the advantage of a sufficient level of transverse strength while known C fiber-reinforced Mg materials are in practice not used because their strength transversely with respect to the fiber direction is too low.

In accordance with the invention the Mg material according to the invention comprising a matrix with a C long-fiber reinforcement can be used to produce pistons of internal combustion engines. Conventional pistons of internal combustion engines usually comprise steel or an Al alloy. A desired reduction in weight in comparison with pistons of steel or Al alloys can be achieved by the use of Mg alloys. Hitherto however they have not enjoyed sufficient strength, rigidity and creep resistance. As is known a slight increase in strength can be achieved if such Mg alloys are reinforced with short fibers or with suitable particles. That slight increase in strength however is still not sufficient. Adequate strength, rigidity and creep

resistance is only achieved with the Mg material according to the invention comprising a matrix with a C long-fiber reinforcement, wherein the C long fibers are provided with a thin layer of the above-indicated kind. In the case of the Mg material according to the invention the interface strength as between the C long fibers and the matrix is optimised. By virtue of a suitable configuration and fiber arrangement, when using the Mg material according to the invention in pistons of internal combustion engines, it is possible to achieve a saving in weight of up to 30%. The composite material according to the invention consisting of the matrix and the C long-fiber reinforcement has levels of strength which are comparable to those of high-strength Al alloys, in the critical regions and directions of an internal combustion engine piston. The rigidity levels are even higher than the high-strength Al alloys. Force-application regions such as for example the bearing bosses for gudgeon pins, grooves for piston rings and possibly piston crowns or combustion chambers can be in the form of inserts which in turn can be made from higher-strength metal alloys or from composite materials and which, with the component consisting of the Mg material according to the invention, form a composite assembly joined in positively locking relationship and/or joined by the materials involved.

The Mg material according to the invention comprising a matrix with a C long-fiber reinforcement, wherein the C long fibers are provided with a thin layer, as has been described hereinbefore, can also be used in accordance with the invention for the production of connecting rods of internal combustion engines. The connecting rods used in internal combustion engines at the present time usually comprise steel or a Ti alloy. Tests have also already been conducted with GRP and CRP connecting rods. A reduction in weight in comparison with connecting rods of steel or Ti alloys can be achieved by the use of Mg alloys. However they do not offer adequate strength and rigidity. A slight increase in strength is possible if such Mg alloys are reinforced with short fibers or with particles. However such an increase in strength is still not sufficient. Adequate strength and rigidity are first afforded by the use of the Mg material according to the invention comprising a matrix with a C long-fiber reinforcement with a thin

layer, as has been described hereinbefore, by which the interface strength between the matrix and the C long fibers is optimised. By virtue of a suitable configuration and fiber arrangement, it is possible to achieve a saving in weight of up to 70% with the Mg material according to the invention, in respect of connecting rods. In the critical regions and directions of connecting rods, the Mg material according to the invention affords levels of strength which are comparable to those of high-strength Al alloys. The levels of rigidity are even higher than those of Ti alloys. Force-application regions such as the bearing eyes for the gudgeon pins and for the crank pins can be in the form of inserts which in turn can be made from higher-strength metal alloys or from composite materials. Those inserts can form with the component of the Mg material according to the invention a composite assembly joined in positively locking relationship and/or by the materials involved.

In accordance with the invention the Mg material according to the invention can also be used for the production of propulsion bases for sub-caliber projectiles and shells. Known propulsion bases usually comprise high-strength Al alloys. A reduction in weight can be achieved with such propulsion bases by the use of Mg alloys. The known Mg alloys however are not of sufficient mechanical strength. Only slight increases in strength are possible with known Mg alloys, by means of short-fiber or particle reinforcements. It is here that the Mg material according to the invention provides a remedy so that, by virtue of a suitable configuration and fiber arrangement of the Mg material according to the invention, it is possible to achieve a saving in weight of between about 20 and 30%. The Mg composite material according to the invention with C long-fiber reinforcement with the thin coating, as has been described hereinbefore, is of levels of strength which are comparable to those of high-strength Al alloys, in critical regions and directions. The levels of rigidity are even higher than the high-strength Al alloys. Force-application regions such as for example a screwthread in relation to the penetrator can be in the form of inserts which in turn can be produced from higher-strength metal alloys or from composite materials and which can be connected to the

component, that is to say the propulsion base, comprising the Mg material according to the invention, in positively locking relationship and/or by way of the materials involved.